**Docket No. SA-537**

**Exhibit No. 14-F**

# NATIONAL TRANSPORTATION SAFETY BOARD

**Washington, D.C.**

Boeing, International Air Transport Association (IATA), and International Federation of Air Line Pilots Associations (IFALPA) Study: Airline Pilot Perceptions of Training Effectiveness

(25 Pages)

# Airline Pilot Perceptions of Training Effectiveness

**Barbara Holder, PhD**
Flight Deck Concept Center
Boeing Commercial Airplanes
barbara.e.holder@boeing.com

## Introduction

In collaboration with the International Air Transport Association (IATA) and the International Federation of Air Line Pilots Associations (IFALPA), Boeing surveyed the professional airline pilot community for their perspectives on training and the effectiveness of training transfer to operational contexts. The results indicate that improvements are needed in the areas of instruction, content, and delivery methods.

The survey explored pilot perceptions of current training and the effectiveness of their application to the operational context of airline flying. The survey objective was to identify areas where training may need improvement and to identify targeted interventions or future research activities. The survey questions were drafted during the September 2010 meeting of the Instructor Qualification and Training Initiative, Evidence-Based Training team. Access to the survey was provide via a link on the International Federation of Air Line Pilots Association (IFALPA) website through May of 2011. IATA member airlines and IFALPA members were solicited for participation in the survey via email. All responses were anonymous.

The results of this survey will be added to the International Air Transport Association (IATA) data corpus, which includes data from Line Oriented Safety Audit (LOSA) reports, global accident and incident data, and other surveys. Because this survey was conducted to supplement the IATA Evidence-Based Training (EBT) initiative the probe topics were defined by the EBT data team.

## Pilot Demographics

Nine hundred and sixty-six pilots completed the survey: fifty-six percent captains and forty-four percent first officers. Figure 1 illustrates the regional distribution of respondents with majorities based in Europe, North America, and Oceania. We attribute the higher response rates in these regions to the higher IFALPA and IATA representation across these regions. Other regions represented were Middle East, Asia, Central and South America, Africa, and the Commonwealth of Independent States (CIS).

| | |
|---|---|
| Europe | 49.5% |
| North America | 21.4% |
| Oceania | 14.6% |
| Middle East | 7.0% |
| Asia | 3.9% |
| Central/S. America | 2.2% |
| Africa | 1.2% |
| CIS | 0.2% |


**Figure 1. Global Distribution of Survey Participants**

## Training Delivery

94% of the pilots reported they are trained by their airline while the remaining 6% are trained by another provider (Figure 2). Therefore instituting change in training practices will require change at the airline, something they must be motivated to do and regulators must be motivated to approve change.

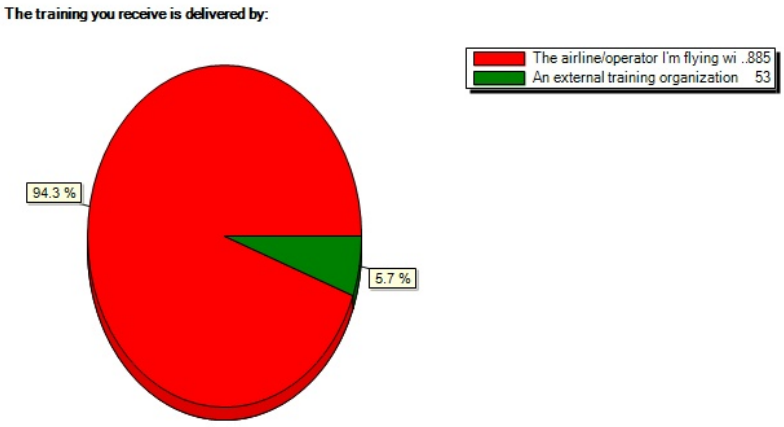


**Figure 2. Pilot Training Delivery**

The type of training most recently completed by the respondents was recurrent training (86%) and responses are likely to be framed in that context (Figure 3).

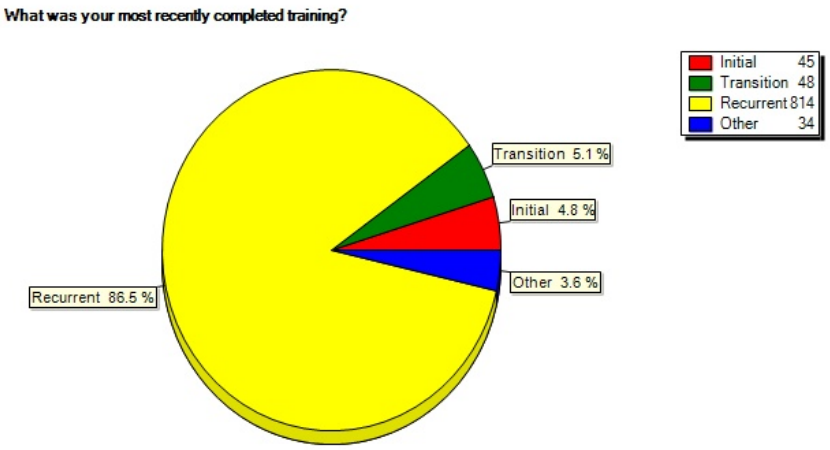


**Figure 3. Recently Completed Training**

## Automation

Flight management automation is a known area of difficultly for pilots both in training and in flight operations and the results suggest it's still an issue. Our next question asks if pilots had difficulty performing tasks with the Flight Management System (FMS), in the first six months of flying their current aircraft type. This question was framed in the first 6 months in order to assess the subjective feeling of transfer of knowledge from training to line operations. Most pilots (56%) reported they had difficulty a few times (Figure 4). Only 5% reported they had frequent difficulty and 14% experienced difficulty only once.

We asked the pilots to estimate their level of "comfort" in operating the flight management system after completing the type rating course. Comfort is a term pilots frequently use to describe confidence in their ability to perform. The question was framed in terms of time increments following the type course to identify the time by when comfort is acquired. Respondents could choose one of the following categories: on your first aircraft flight, after initial operating evaluation (IOE), after three months of operation, after six months of operation, and after twelve or more months of operation (Figure 5).

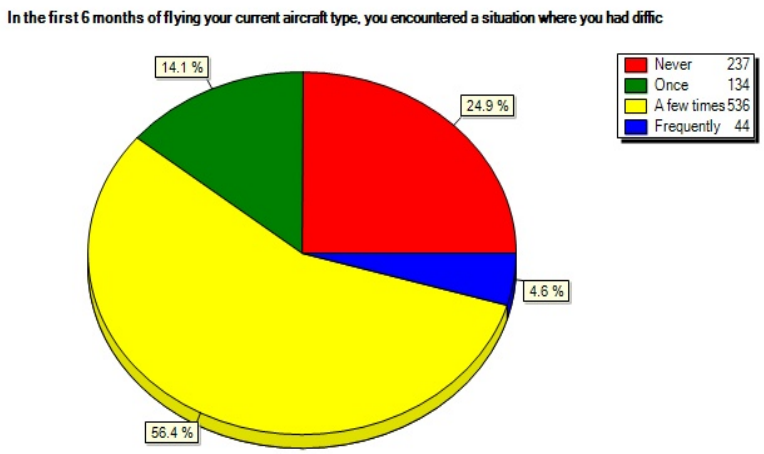


**Figure 4. In the first 6 months of flying your current aircraft type… You encountered a situation where you had difficulty performing particular tasks using the Flight Management System.**

Most pilots (62%) felt comfortable operating the FMS only *after* gaining line experience. A few (15%) were comfortable after their initial operating experience (IOE) and 23% were comfortable on their first flight in the airplane. Forty-one percent reported comfort after three months of line operations, after six months (15%) and after twelve months (7%).

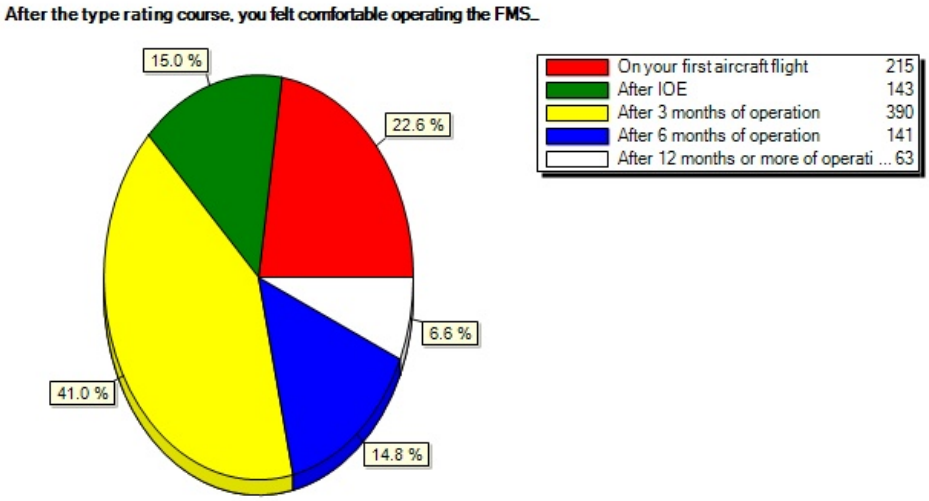


**Figure 5. When Pilots Felt Comfortable Operating FMS After Type-Rating Course**

If the type-rating course does prepare pilots for line operations, we would expect their reported comfort level to be high after completion of training (Figure 5). It appears some training programs do

instill pilot confidence on their first aircraft flight after training because 23% reported being comfortable operating the FMS on their first flight.

These results raise some interesting questions about what is being learned after IOE that enables the development of perceived comfort that could be introduced into training earlier. Further work should identify what specifically constitutes effective learning on the line.

The next question identifies where flight management learning occurs. The respondents were asked to estimate how much learning occurs across the following three methods:

- FMS learning on the line—42%.
- FMS learning from training—38%.
- FMS learning through self-study—20%.

These results raise many questions but in particular, if 42% of the learning occurring during line operations what is being learned and is it appropriate? How might content and delivery of FMS training be improved so that line learning is not required? If learning on the line is required, what does effective line training look like?

Even though pilots reported a substantial amount of FMS learning occur on the line, 58% rated the quality of their FMS training to be adequate or excellent. Unfortunately we did not ask them what constitutes "adequate" but 42% reported their FMS training to be "minimal with room for improvement" or "inadequately covers the operational use of the FMS" (Figure 6).

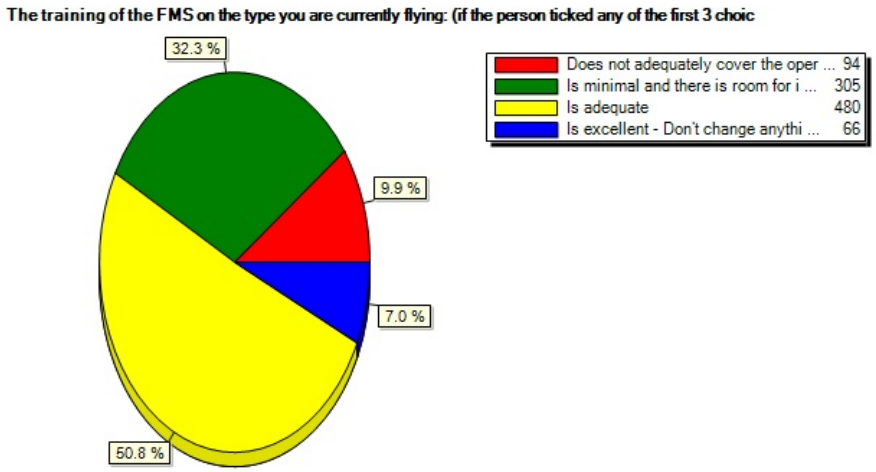


**Figure 6. Ratings of FMS training quality.**

Next we inquired about specific areas of FMS training that could be improved and pilots were permitted to select up to three options (Figure 7). Operational situations such as automation surprises (57%), hands-on use in operational situations (52%), and transitions between modes (32%), received

the highest response rates. Pilots also citied basic knowledge of the system and programming as areas for improvement.

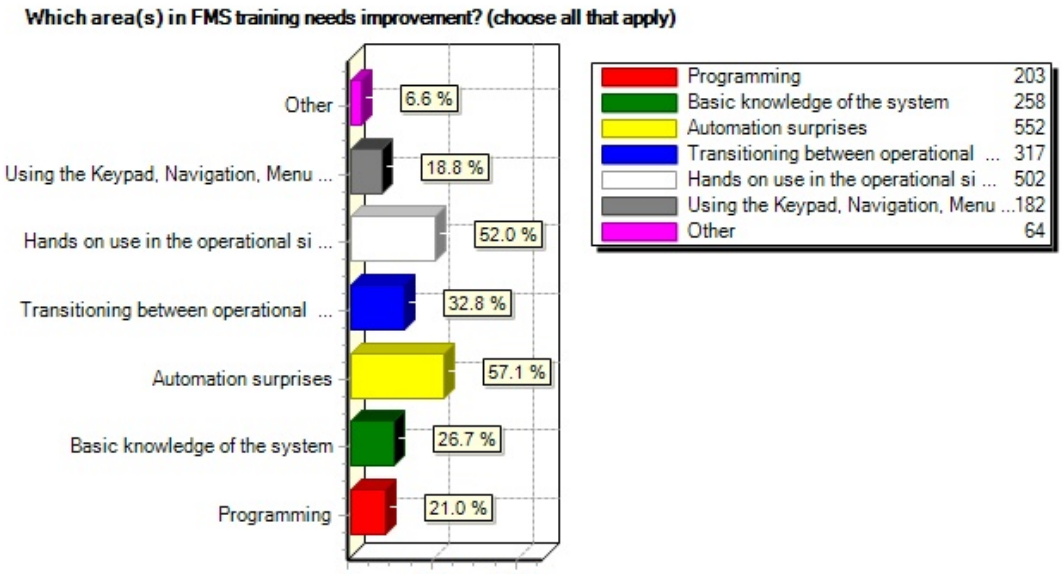


**Figure 7. Potential Areas of Improvement for Automation Training**

## Go-Around Maneuvers

The industry currently regards go-around maneuvers as a safety issue because they are either poorly executed or not executed when they should be. The next series of questions inquired about the decision to execute a go around. We asked: Did you encounter situations where there should have been a go-around but the approach was continued to a landing? If they answered yes, they were presented with three options:

1. I suggested a go-around, but the other pilot disagreed (20%).
2. The other pilot suggested a go-around, but I disagreed (8%).
3. Neither pilot suggested a go-around (72%).

In 72% of the reported cases neither pilot suggested a go-around and of the remaining cases (28%) the pilots did not agree to go-around. Pilots were permitted to report up to five go-around cases and in all cases, the main result was: neither pilot suggested a go-around. We asked the pilots to report their rank (captain, first officer) and role (pilot flying, pilot monitoring, and augmented crew). In the cases when one pilot suggested a go-around and the other pilot disagreed, we correlated their rank to compliance with the suggestion of a go-around (Table 1). The results indicate that rank influences the decision and communication patterns between pilots during the negotiation of a go around. Although a pilot may feel he can suggest a go-around or even demand one from the pilot flying, the other pilot

may not comply. Neither pilot suggesting a go-around may be due to the pilots' ability to make the approach work and apply judgment to maintain safety.

**Table 1. Distribution of Responses by Rank**

| Response Categories | Captain | First Officer |
|---|---|---|
| I suggested a go-around, but the other pilot disagreed | 13.8% | 27.6% |
| The other pilot suggested a go-around, but I disagreed | 12.3% | 2.8% |
| Neither pilot suggested a go-around | 73.9% | 69.7% |

The next question inquires about how assertive in the role of pilot monitoring across different contexts (Figure 8). Pilots reported high levels of assertiveness in four of the five categories, with taking control from the pilot flying registering the lowest at forty-nine percent. The level of reported assertiveness appears to be linked to the level of intervention required. Tasks such as identifying a deviation (92%) or proposing a checklist (91%) are more likely to be asserted than tasks with an intervention or decision underlying it such as a go-around (83%) or demanding a go-around (80%).

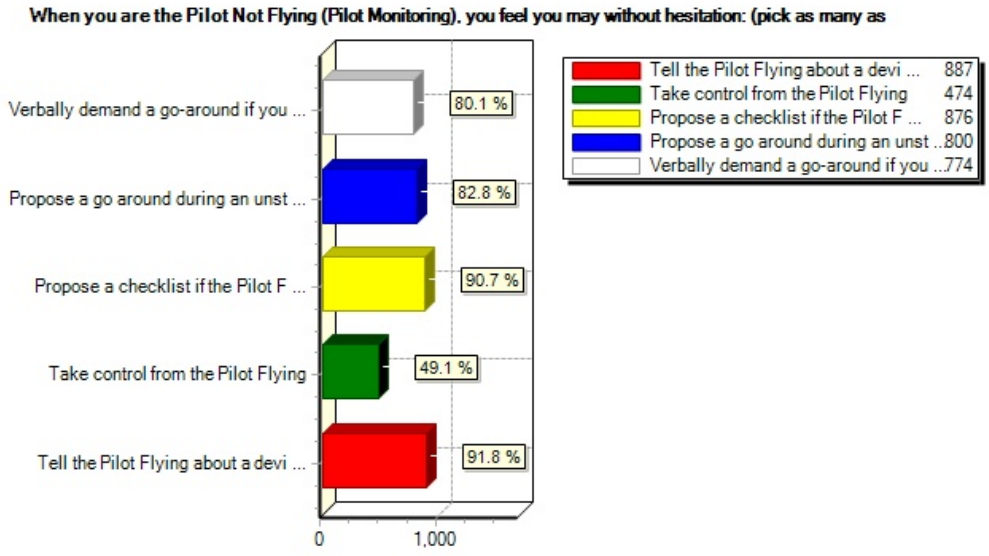


**Figure 8. Distribution of Responses to Assertiveness**

The Line Operations Safety Audit (LOSA) database suggests that ninety-seven percent of unstable approaches are continued to landing. We asked the respondents to make a judgment about why another pilot would not initiate a go-around to identify potential rationale for not doing the maneuver. We asked: In your opinion what are the reasons for not initiating a Go-Around? They were presented with the six following options and could choose up to three options:

a. According to the judgment by the pilot, the landing can be performed safely
b. There is a big psychological barrier to go around because they are so rare events
c. Operational inconvenience
d. Embarrassment related to a go around
e. Pilots are not as familiar with unstable approach criteria as they should be
f. Making a go-around mandates a report

Pilot judgment was most cited (82%) as the reason a pilot would choose not to go around if the approach was unstable (Table 3). This finding is not surprising because one of the primary roles of pilots is to apply judgment and interventions in the moment-to-moment context of activity. However, it is our assessment that most training programs train judgment implicitly rather than explicitly.

The next two major category responses were psychological barriers (37%) and operational inconvenience (35%). Psychological barriers may be perceived by pilots who do the maneuver infrequently in operations and in training. It is important to build a pilot's confidence in his skills by providing opportunities to practice the maneuver across contexts (such as all engine go around). Operational inconvenience could be a safety concern if pilots are choosing to not go around for the wrong reasons.

**Table 3. Reasons for Not Choosing Go-Around**

| Response Categories | Distribution |
|---|---|
| Pilot judgment | 82% |
| Psychological barrier | 37% |
| Operational inconvenience | 35% |
| Embarrassment | 24% |
| Unfamiliar with criteria | 17% |
| Mandates a report | 10% |

## Monitoring and Cross-Checking

The next questions inquire about the pervasiveness of error management in flight training and the perceived value as a skill. Monitoring and cross-checking, two key components of error management, are perceived as important piloting skills (Figure 9). Forty-seven percent of the pilots reported the topic of detecting and managing errors are included in their recurrent training as a specific topic in both theory and practice. However the remaining respondents reported the topic as implicitly covered, marginally covered, or not covered at all. Although a majority of pilots believe these are important skills, the results suggest they are not always explicitly trained and practiced in the training environment and perhaps guidance materials for training monitoring and cross-checking skills may be needed.

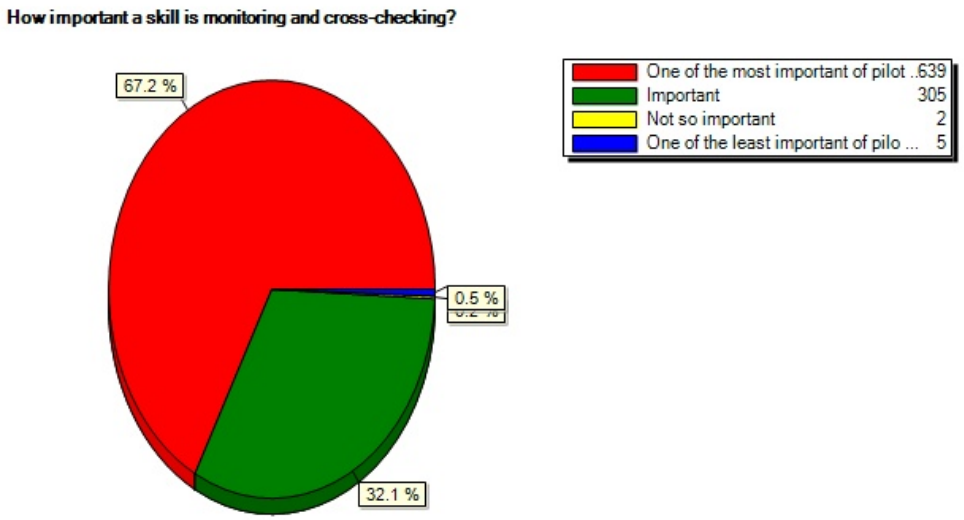


**Figure 9. Monitoring and Cross-Checking**

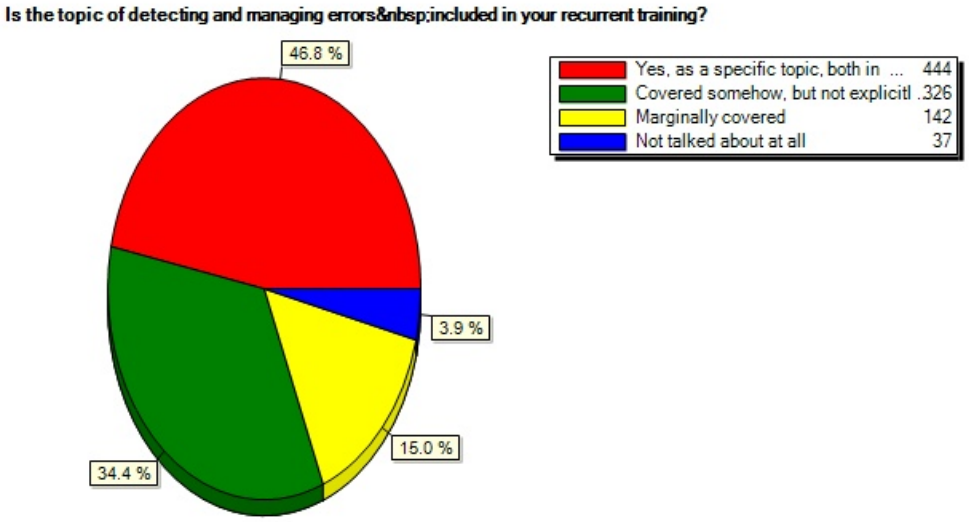


**Figure 10. Inclusion of Error Management in Recurrent Training**

The LOSA reports identified the *climb phase of flight* as one with the highest rate of poor monitoring performance. We asked the pilots why this might be the case and they responded that complacency and secondary task loading are the causes of degradation in monitoring during the climb. (Figure 11). Complacency may be induced by the transition from a high workload flight phase to lower workload flight phase.

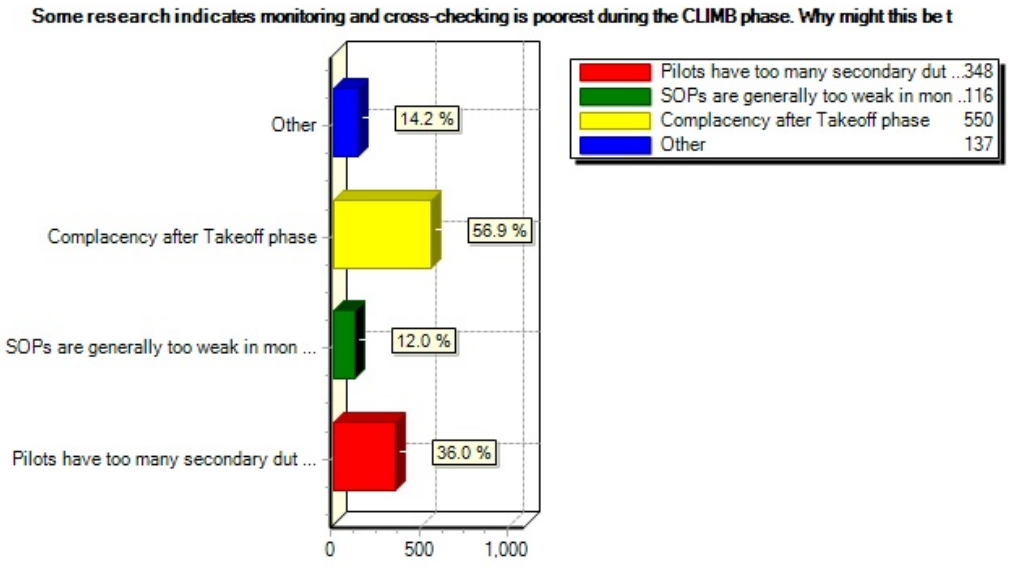


**Figure 9. Monitoring and Cross-Checking During Climb**

Monitoring tasks may be dropped for competing secondary task demands. In training, monitoring should be emphasized as a primary task and pilots should be trained on what to monitor, how to monitor, and when. We should also give pilots strategies for managing their workload in all flight phases so that monitoring is not dropped inappropriately.

Regarding strategies for error management, 90% of the respondents believe detecting and managing errors is most effective. A small percentage of pilots (7%) believe that errors should not be committed (Figure 12).

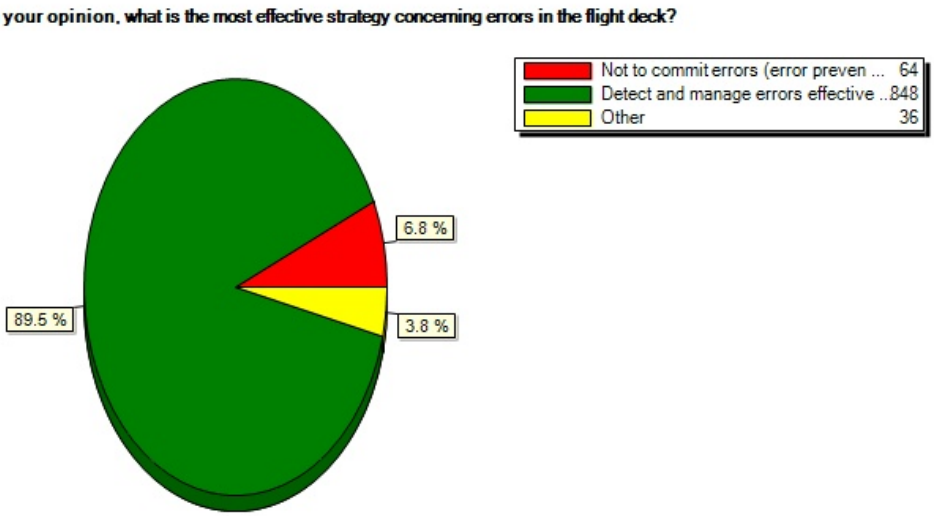


**Figure 12. Strategy for Error Management**

## Briefings

Briefings present an important opportunity for pilots to construct a team concept and build shared understandings and expectations. It is important that briefings be included in training so pilots have the opportunity to practice these skills and receive feedback on their content, duration, delivery, and effectiveness.

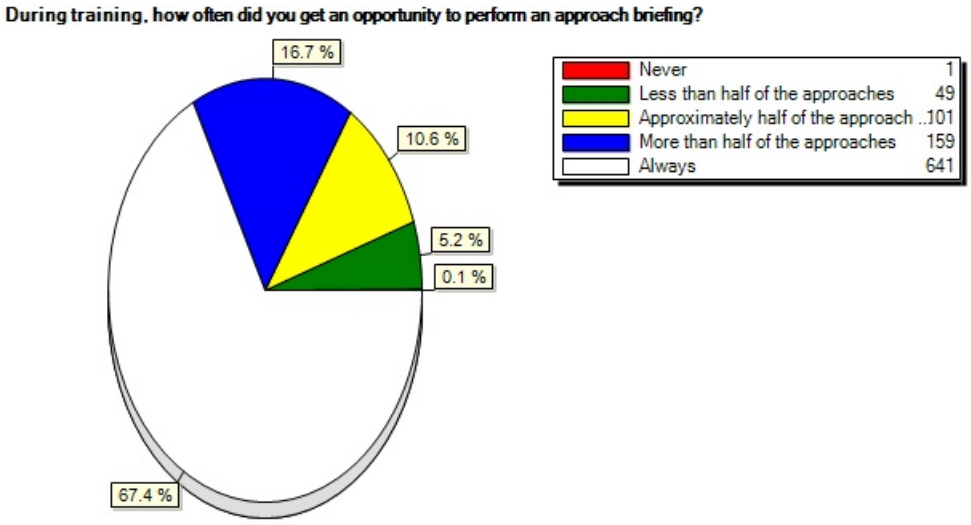


**Figure 13. Approach Briefing Frequency in Training**

Approach briefings are included in training (Figure 13) however a number of respondents commented that appropriate briefing content is generally not known or practiced. Still it is a positive finding that pilots get an opportunity in the training environment to practice briefings.

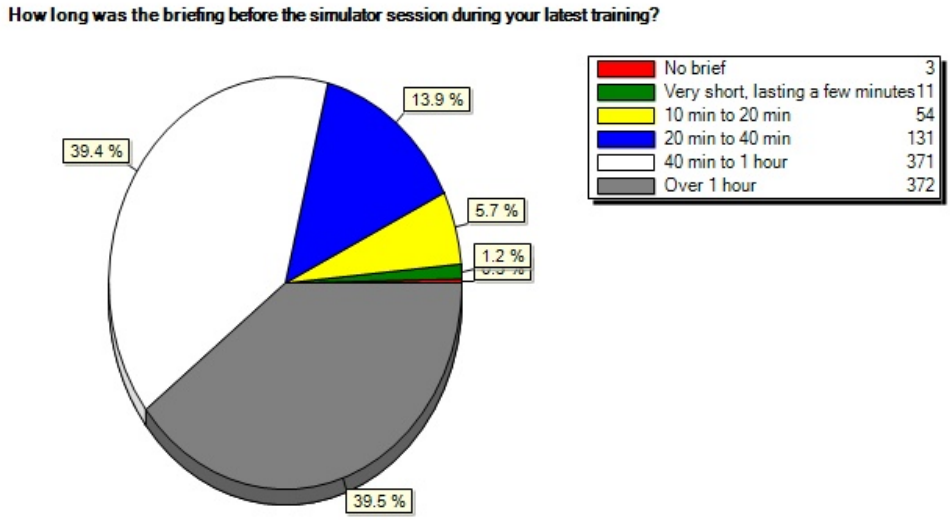


**Figure 14. Briefing Duration Before Simulator Session**

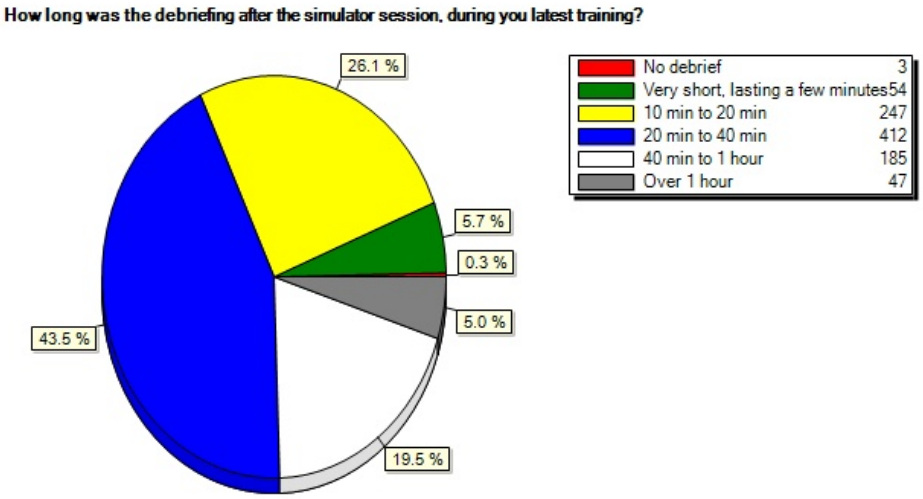


**Figure 15. Debriefing Duration After Simulator Session**

Briefings prior to the simulation sessions are regularly included in training and present a potentially valuable opportunity for focused discussion (Figure 14). These sessions tend to be 20-30 minutes longer than the debriefing sessions (Figure 15) which are vulnerable to dismissal due to time constraints or late night sessions.

## Intentional Deviations

Part of a pilot's expertise involves knowing when to intervene or deviate from standard operating procedures (SOP). We were interested in the frequency and conditions under which pilots might deviate from their company's Standard Operating Procedures (Figure 16).

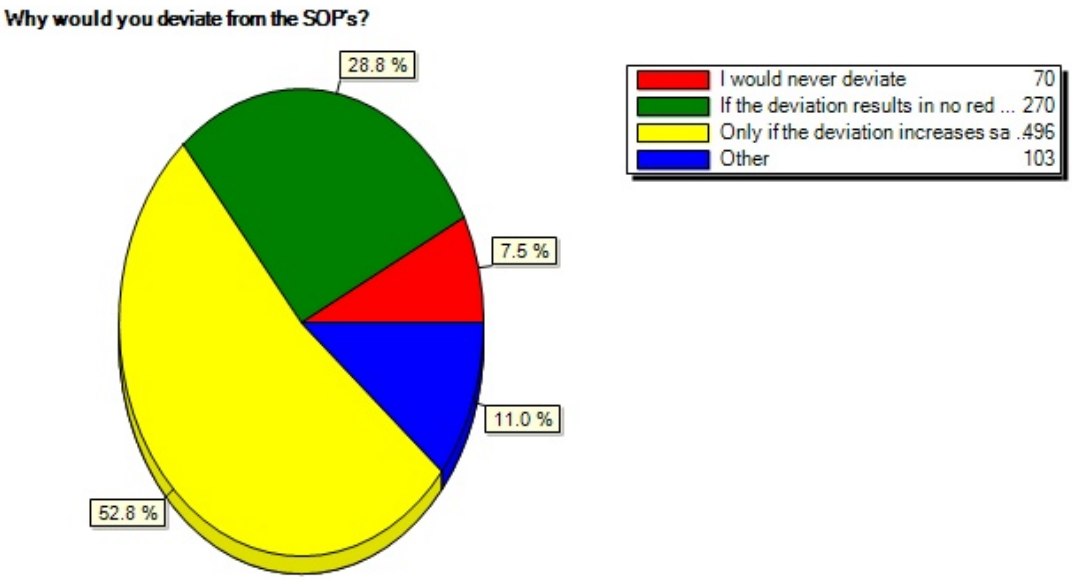


**Figure 16. Frequency of Pilot Deviation From SOPs**

A majority of the respondents (53%) would deviate if it increases safety and 29% would deviate if it resulted in no reduction in safety. 83% of the pilots would exercise judgment to intentionally deviate from their company SOPs with their judgment being the pilot's assessment of safety. Another 7% reported they would never deviate and 11% did not specify an answer. In the next series of questions we asked pilots to identify specific intentional deviations they have experienced on the flight deck.

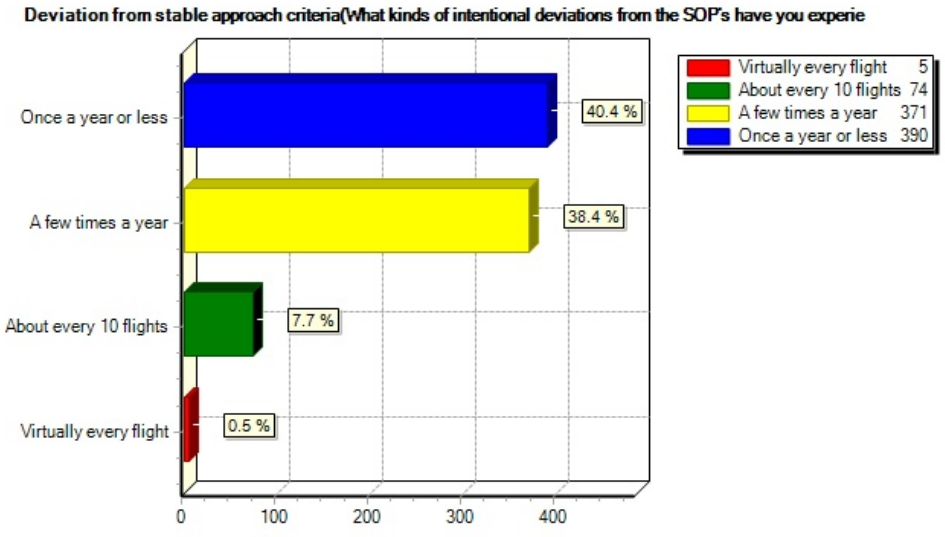


**Figure 17. Frequency of Intentional Deviation From Stable Approach Criteria**

Intentional deviations from stable approach criteria were reported to occur at a rate of once per year by 40% of the respondents and more than a few times a year by 38% of the respondents (Figure 17). However, some pilots report intentional deviations from stable approach at a higher rate of every ten flights, or virtually every flight. Further inquiry into stable approach deviations should identify the contexts in which these judgments are made and why they are made. It would seem these rates are suggestive of conflict between the defined criteria and the realities of the operational context.

Intentional deviations from checklists occurred a reported every ten flights by 13% of the respondents, a few times a year by 30% of the respondents, and once a year by 36% of the respondents. Very few (4%) reported a deviation on every flight. Checklist deviations occurring at this high of a rate suggest other factors may be involved not related to compliance.

There may be many reasons for pilots to deviate from procedures. Pilots may deviate from procedures without intending to do so. Perhaps the pilot does not know the procedure or policy or understand it. The procedure may not make sense to the pilot or it may not fit into the operational context where it is to be applied. Procedures can be interrupted by competing demands on attention resulting in non-compliance. Poorly designed procedures may impose excessive cognitive workload making them difficult to perform correctly.

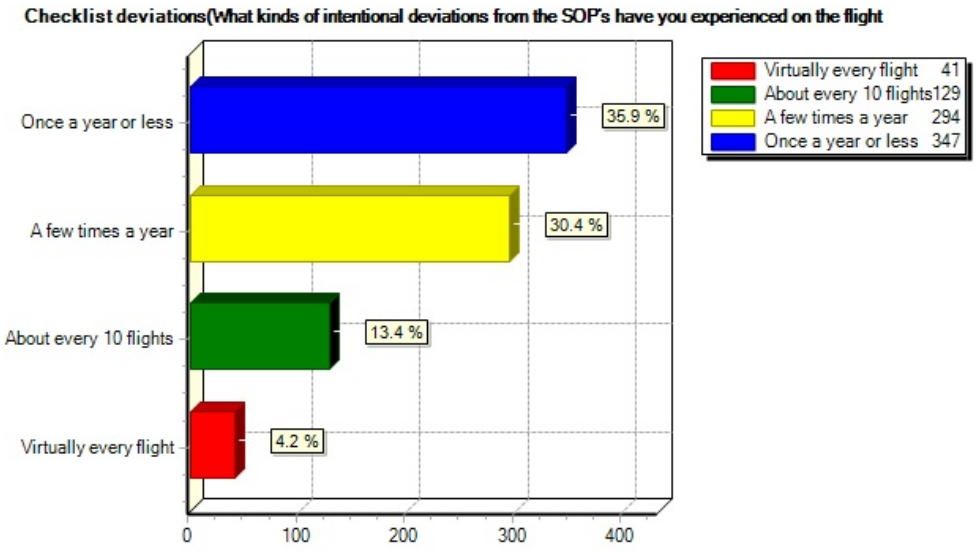


**Figure 18. Frequency of Intentional Deviation From Checklist**

Callouts had a high intentional deviation rate with about half the respondents (49%) reporting deviations on every 10 flights and virtually every flight (Figure 19). There are several possible reasons why non-compliance is high, most again not necessarily related to compliance. Callouts serve an important purpose of establishing shared understandings and representations of the situation. If pilots do not understand the purpose of the callout or if the callout does not fulfill the purpose by design then we would expect pilots to not use them. The shear number of callouts to remember may be a reason for not making them; pilots may simply forget to make them in the context of a demanding situation or a lapse in monitoring, or the pilots may not feel they are important. If we are to understand intentional deviations from callouts, we will need to investigate the specific callouts deviated from and the contexts of their occurrence and provide guidance on appropriate training of callout use.

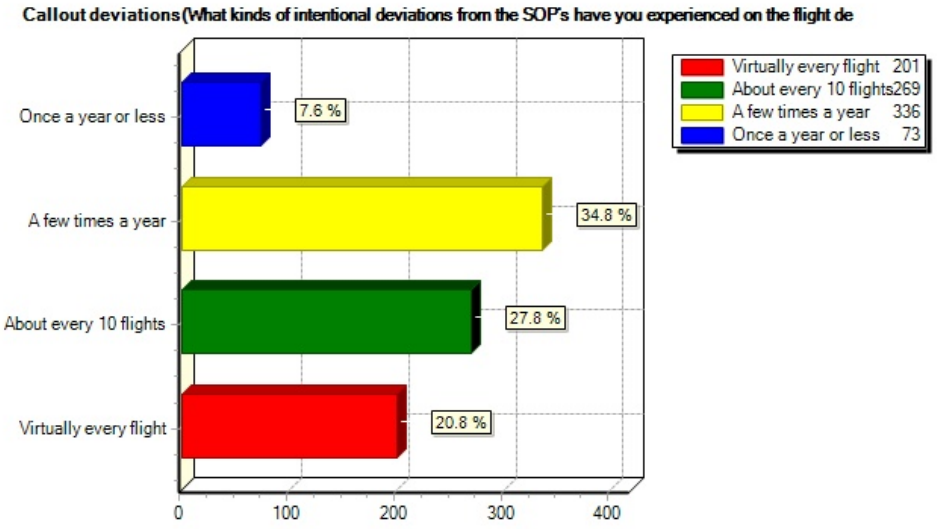


**Figure 19. Frequency of Intentional Deviation From Callouts**

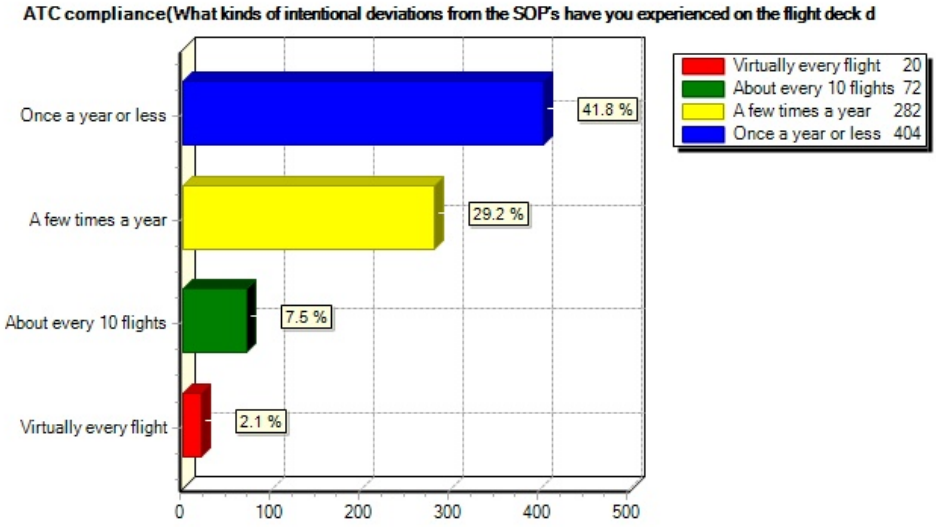


**Figure 20. Frequency of Intentional Deviation From Callouts**

The frequency of ATC deviations was much higher than we expected. Forty-two percent reported deviating once a year while 29% deviate a few times a year and 7.5% about every ten flights. This is an area work further investigation to identify the root causes of the deviations.

## Operational Situations

It is important that the knowledge and skill acquired in training transfer to actual operations. The next question probed for areas where knowledge and skill transfer to line operations may falter and suggest current gaps in training. We asked, “In the last six months, did you encounter an operational situation where you did not feel comfortable?” Just over half (54%) of the respondents answered yes and 57% of them are ranked captain and 43% are ranked first officer (Figure 21).

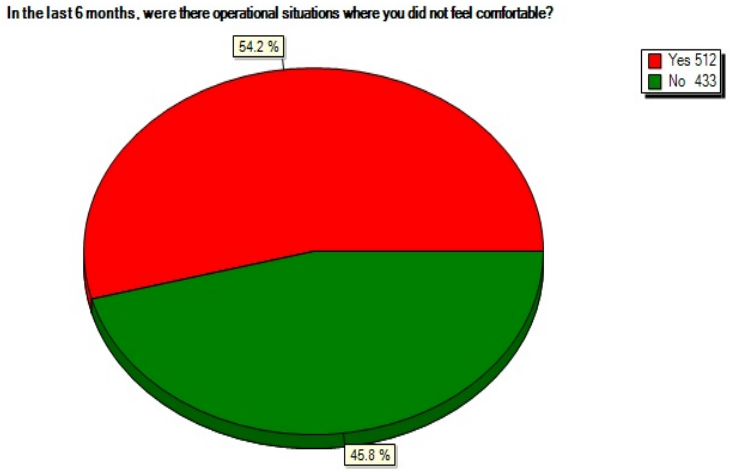


**Figure 21. Experienced Uncomfortable Operational Situations During Last Six Months**

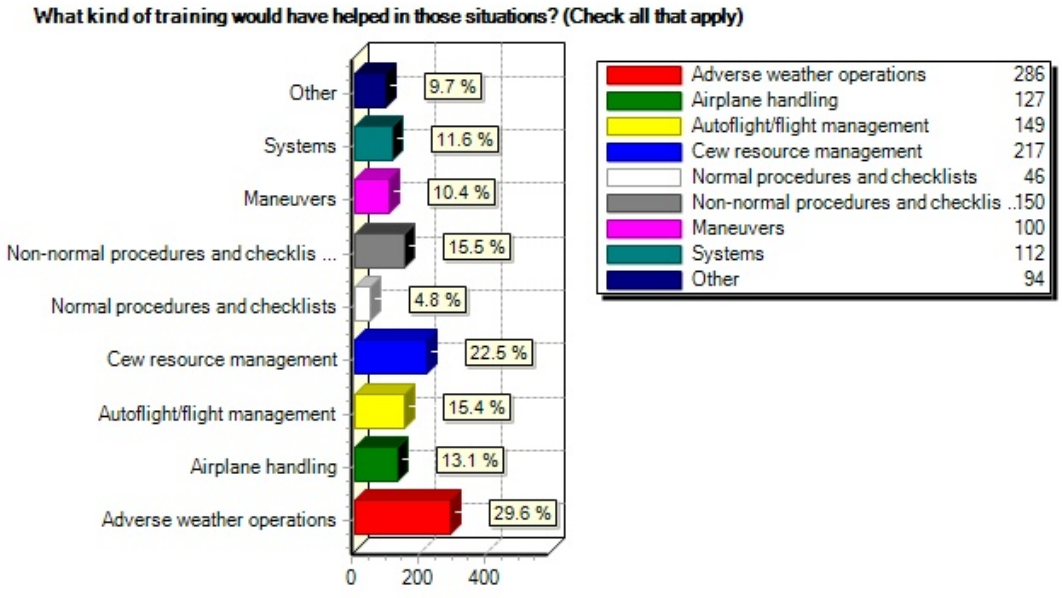


**Figure 22. Training that might have helped in dealing with an uncomfortable operational situation.**

Pilots were then asked to indicate what kind of training would have helped in the situation and to select all areas of training that would have helped (Figure 22.) Adverse weather (30%) and Crew Resource Management (23%) were highest with non-normal checklists (16%), flight management (15%), airplane handling (13%), systems (12%), and maneuvers (10%) following. The distribution across these events suggests if training is occurring at the airline on these topics it may not be transferring effectively to the operational contexts where they occur.

All pilots reporting an uncomfortable operational situation were asked to describe the situation they encountered. A sample of the responses is presented in Table 4. The specific areas of training that emerged from the responses included:

- Flight management specific to operational tasks: late runway change, reroute, and auto flight mode understanding.
- Procedural issues associated with the introduction of new procedures or changes driven by mergers resulting in "poor" procedure integration.
- Infrequent non-normal events such as low fuel, bird strike, CDU failure, upset recovery, and volcanic ash were also mentioned.
- Cold weather operations such as de-icing procedures, contaminated runway operations, and high altitude turbulence.
- Approaches: non-precision and visual approaches, energy management in the approach, severe crosswinds, and go-around/missed approaches.
- Aircraft handling and maneuvers particularly in regions of mountainous terrain.
- Performance calculations, diversion, minimum equipment list (MEL) items, systems knowledge, and conflict management with a crew member or a passenger.

**Table 4. Uncomfortable Operational Situations Described by Pilots**

| |
|---|
| Runway closure at destination prompting holding and possible divert in busy European airspace |
| Visual circle to land in EWR Rwy 29 due to massive crosswind |
| In everyday ATC requirements of speed and last minute changes, there is no training given |
| While flying at FL400, encountered stick shaker in turbulence due to momentary severe updraft |
| Tailwind approach over steep terrain simultaneously intercepting localizer and glide slope |
| At 37,000 feet, escape maneuver for wake turbulence from heavy aircraft (747) |
| Procedures and terrain unique to foreign airports |
| Planning/performance done manually on contaminated runways with MEL items |

| |
|---|
| Winter operations with contaminated runway and related decision making with regard to takeoff and landing performance |
| U turns on the runway. |

## Negative Experiences in Training

Creating a positive social context for learning is an important role of an instructor and is essential for learning. We asked a series of questions to probe for any negative experiences pilots may have encountered in training. We asked pilots to indicate if their instructor had raised their confidence during their last training session (Figure 23). Unfortunately, 43% of the responses were negative.

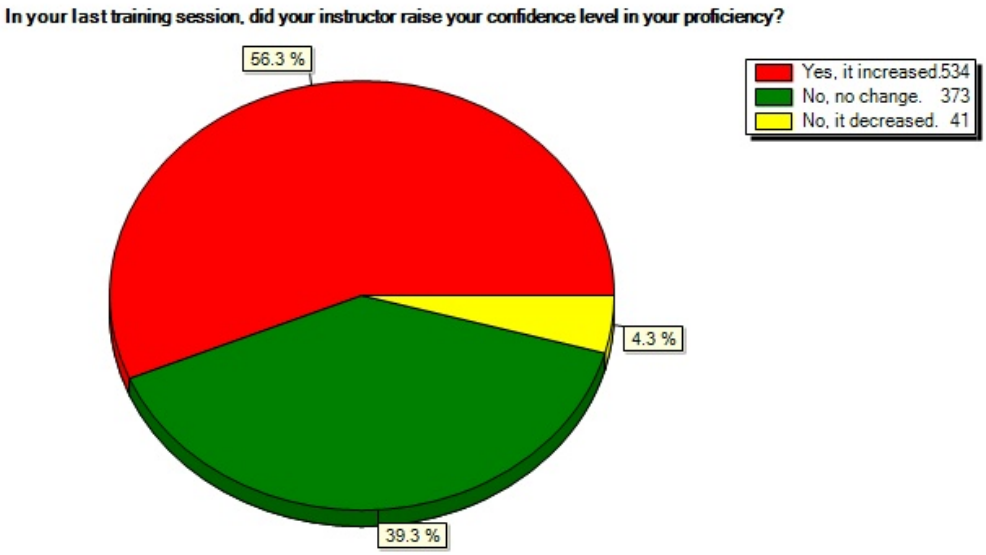


**Figure 23. Instructor Effect on Pilot's Confidence in Proficiency**

The next question probes for any negative experiences encountered in training within the past 5 years (Figure 24). The broad time range was to ensure we captured all possible training cycles. Forty-nine percent of the pilots responded yes they had a negative experience in training within the past 5 years. If the response was yes, we asked the pilots to specify the cause of the negative experience. Responses were coded and grouped by topic (Table 5). The most frequent source of negative experiences in training was the instructor. The other two main categories were training course content and methods of content delivery.

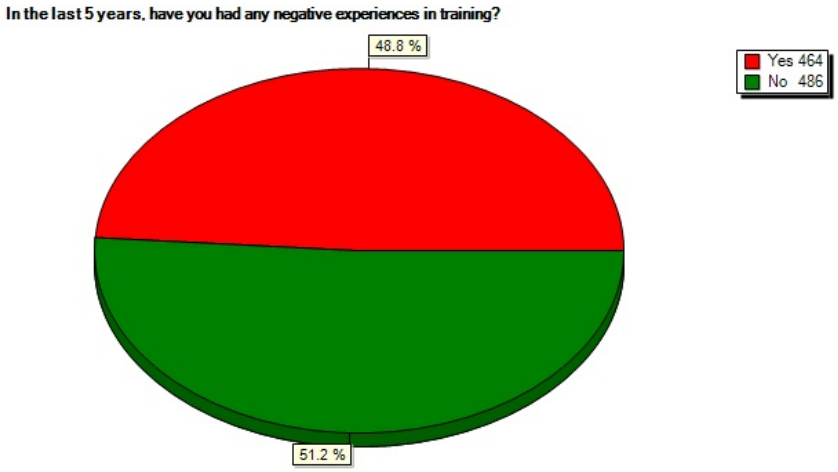


**Figure 24. Pilots Having Negative Training Experiences in Last 5 Years**

**Table 5. Negative Experiences' Codes and Frequency**

| Frequency | Codes for Open Entry Comments |
|---|---|
| 118 | Instructor intimidation |
| 51 | Instructor knowledge deficiency |
| 40 | Instructor standardization |
| 40 | Inappropriate assessment |
| 36 | Unrealistic scenarios or task loading by instructor |
| 36 | SOPs violated by instructor for scenario |
| 36 | Poor syllabus content |
| 35 | Time compression |
| 34 | Disagreement with instructor |
| 34 | Focus on checking |
| 21 | Inappropriate training method |
| 14 | Inappropriate pairing |

| | |
|---|---|
| 12 | No opportunity to practice |
| 11 | Simulator inaccuracy |
| 4 | Poor training manuals |
| 3 | Poor brief prior to simulator |

The results identify specific areas industry could target for immediate improvement in training: instructor competence, relevant and accurate training content, and creating effective delivery methods. Providing comprehensive guidance for instructor qualification, calibration, and standardization should be a top priority. The training environment should facilitate learning and promote the free exchange of ideas, questions, and discussions. Specific examples of negative experiences in training are presented in Table 6.

**Table 6. Some Negative Situations Reported**

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| I had a instructor that loved to "play“ with the flight simulator and I had sessions with 8 multiple faults at the same time, fire, fuel leak, generators’ faults, door opens... it wasn't training was more like a massacre. |
| Training is too geared up to meeting LPC and OPC requirements and so we tend to leave little time for the unusual situations that can arise. Example is engine failure at V1 rarely at V2. |
| Four-hour recurrent session with too many emergencies. Cognitive overload at the end with little learning. |
| There are times you will ask a question and all it does is put a target on your back. |
| Cowboy instructor very nonstandard deviation from **tco**. |
| Check pilots who aren't familiar w/ the "real world." |
| Too much content to cover in the available time leading to nothing being covered adequately. |
| Instructor not understanding priorities and unable to accept that he was wrong and the Capt under check was right. |
| Instructors in my company are not able to tell a captain he is bad. Most of the time the first officers are charged with every mistake. |
| Not teaching, just checking. |
| Nit-picky witch-hunt atmosphere on last evaluation. |
| Instructor who thought he was still in the military and felt the need to yell. Not very conducive to learning. |

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| Variations by check pilots on procedures. |
| Training pilot who would not discuss procedure but demanded we follow his procedure. |

## Anything Else We Should Know

At the end of the survey, we gave pilots an opportunity to comment freely about their training experiences and they provided detail on what they perceive to be key barriers to improved training. Regarding content, they want access to definitive technical information from the airplane manufacturers. Pilots feel they do not get all the information they need via training or through bulletins and other means of communication. Explanation of the rationale underlying the standard operating procedures was frequently requested, "*Explain why SOPs are written that way*." Several wrote that their company's SOPs are not compatible with the operational environment and require "*adaptation of the SOPs to make it work*." Systems training and knowledge were reported to be "*gone*" from training and pilot knowledge and crew resource management training was reported "*ineffective*" or "*absent*." Pilots believe that flight management automation is a "crutch" and hand flying should be encouraged.

Regarding training delivery, pilots cited the issue of being "time compressed" in training courses that do not provide sufficient opportunity to assimilate, think, and reflect on what they are learning. Pilots believe the social interaction of learning in a classroom is superior to distance learning programs and "*ineffective*" self-study. Pilots suggested training occur more frequently and for a reduced duration to enable maintaining proficiency.

We were delighted to receive a few positive comments about training from pilots reporting their company training is "*excellent*" and "*the best training I have ever had*." Pilots expressed their appreciation for the opportunity to participate in the survey and were thankful for being able to share their experiences. Pilots are concerned about their training and want improved training for safety, confidence building, and enhanced performance.

## Conclusion

Current training programs focus on fulfilling regulatory requirements sufficient to meet a minimum level of proficiency but as one of the respondents wrote, "*Passing does not equal preparation*." Our challenge is to introduce needed change in cost-effective ways that motivate airlines to implement change. Regulators will also need motivation to approve training enhancements and to remove barriers to change. The survey results suggest training effectiveness is multi-dimensional and all dimensions must be addressed for interventions to be successful and sustainable. We identified specific areas airlines could target for immediate improvements.

Bringing operationally relevant content into training that is based on operational data will facilitate making the training relevant to the pilots and enabling actual transfer to the operational context. Some of the areas cited as lacking in operational relevance were flight management systems use and conceptual understanding of how the auto flight system will control the aircraft in different operational situations. To support compliance with the standard operating procedures pilots need access to the rationale underlying the procedures and policies they use.

Skills typically branded as "Crew Resource Management" such as decision making, communication, pilot monitoring, and workload management were all identified as needing more deliberate instruction. Although these topics may be addressed in training the training itself was not viewed as sufficient for reliable transfer to line operations. Go-around maneuver training in particular, the ability to recognize when a go-around is the safest option, was identified as an area for improvement. Deviation from the stable approach criteria is another area to target in training, specifically identifying the process pilots use for deciding to deviate and why.

The method of training needs some careful reconsideration. Pilots overwhelmingly requested realistic operational training scenarios be introduced. The one size fits all approach to training profits the adaptation of training to individual learning styles and needs. Pilots are constantly learning their aircraft and its operation through daily experience flying the line. Depending on each pilots own personal history their specific training needs may vary. We hope that by employing modern training methods focused on adult learning that we can create more adaptive and specific training.

Instructors are critically important for effective training. They deliver the content, create context, fill gaps, communicate experience, motivate, and build confidence, but they can destroy all very easily and make training a stressful, negative experience not conducive to learning. To be effective, instructors must receive qualification and be calibrated with proper validation criteria. It is crucial that instructors maintain familiarity with the operational challenges the pilots they train face on a daily basis. Change to the instructor qualification and instructional practices would yield an immediate improvement to training experience and effectiveness.

Training should be a positive experience that prepares pilots for whatever challenge they may face in actual operations. To make change happen on a global scale very clear validated guidance for content development and training implementation will be needed with regulatory engagement.

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